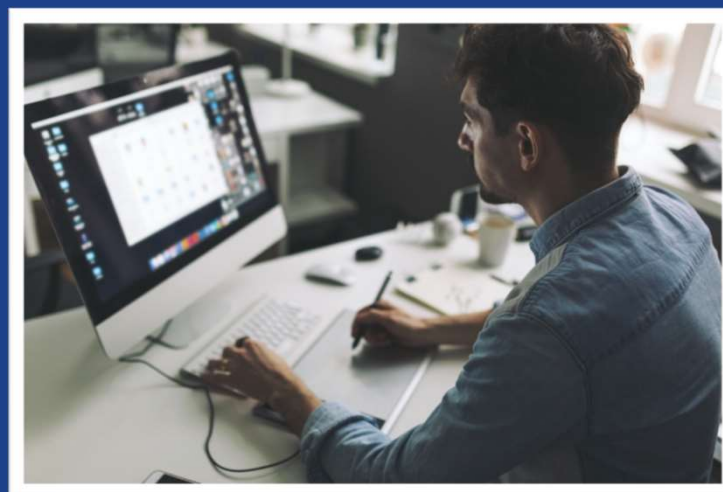


## Better Plants Online Learning Series

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**We'll be starting in just a few minutes....**

Visit our [Online Learning Series](#) page on the Solution Center to see our full series lineup, RSVP, and access previously recorded webinars.





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## Online Learning Series – Webinar #11 MEASUR Tool Suite

Eli Levine

Office of Energy Efficiency and Renewable Energy



Eli Levine

U.S. Department of Energy



## Better Plants Online Learning Series

Webinar Topic	Speaker	Date	Time	Link
7. Energy Treasure Hunts with EPA	Alex Floyd (Tyson) Walt Brockway (ORNL) Walt Tunnessen (EPA)	08/20/20	1:00 – 2:00pm EST	
8. Pumps and Fans	Thomas Wenning (ORNL)	08/27/20	1:00 – 2:30pm EST	
9. Process Heating and Waste Heat Reduction	Sachin Nimbalkar (ORNL)	09/03/20	1:00 – 2:30pm EST	
10. Field Validation	Eli Levine (DOE) Paul Sheaffer (LBNL)	CANCELED	Rescheduled Date <b>TBD</b>	
11. Energy Management During a Pandemic	TBD	09/17/20	1:00 – 2:00pm EST	
12. MEASUR Tool Suite	Kristina Armstrong (ORNL)	09/24/20	1:00 – 2:00pm EST	
13. Process Cooling	Wei Guo (ORNL)	10/01/20	1:00 – 2:30pm EST	<a href="#">Register</a>

---

Please go to [www.slido.com](https://www.slido.com)

using your mobile device, or by opening a new window

Enter Event Code

**#DOE**

# Agenda for Today

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**1** MEASUR Introduction

**2** Software Demo

**3** Q&A using Slido



**Kristina Armstrong**  
Oak Ridge National Lab



## Using the MEASUR Tool Suite

Kristina Armstrong

Thomas Wenning

Gina Accawi

Eli Levine (DOE)

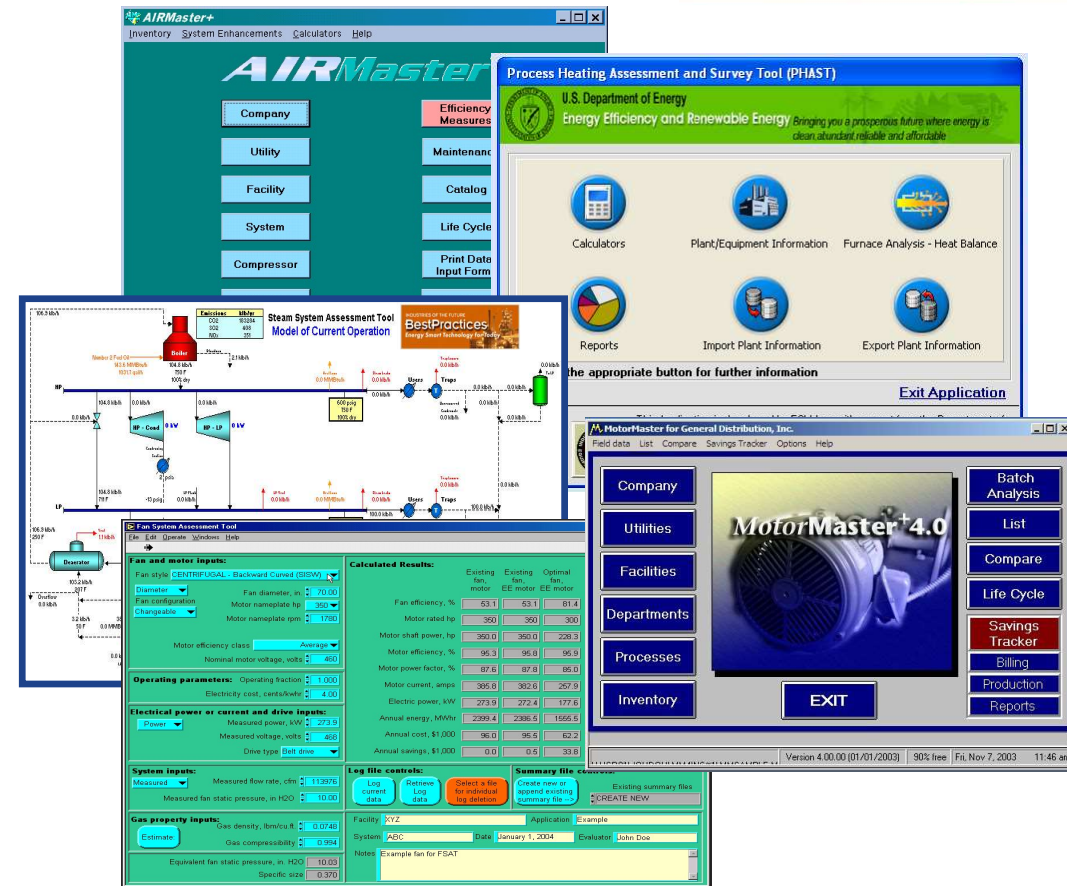
Oak Ridge National Labs





# AMO Software Tool History

- Technology & Vendor Agnostic tools for energy savings analysis
  - Identify
  - Quantify
  - Validate
- Developed in the '90s – '00s
  - With Industry Experts
  - Many no longer work on today's operating systems



# AMO Software Tool Modernization

## ■ Modern Application

### ■ Open Source Software

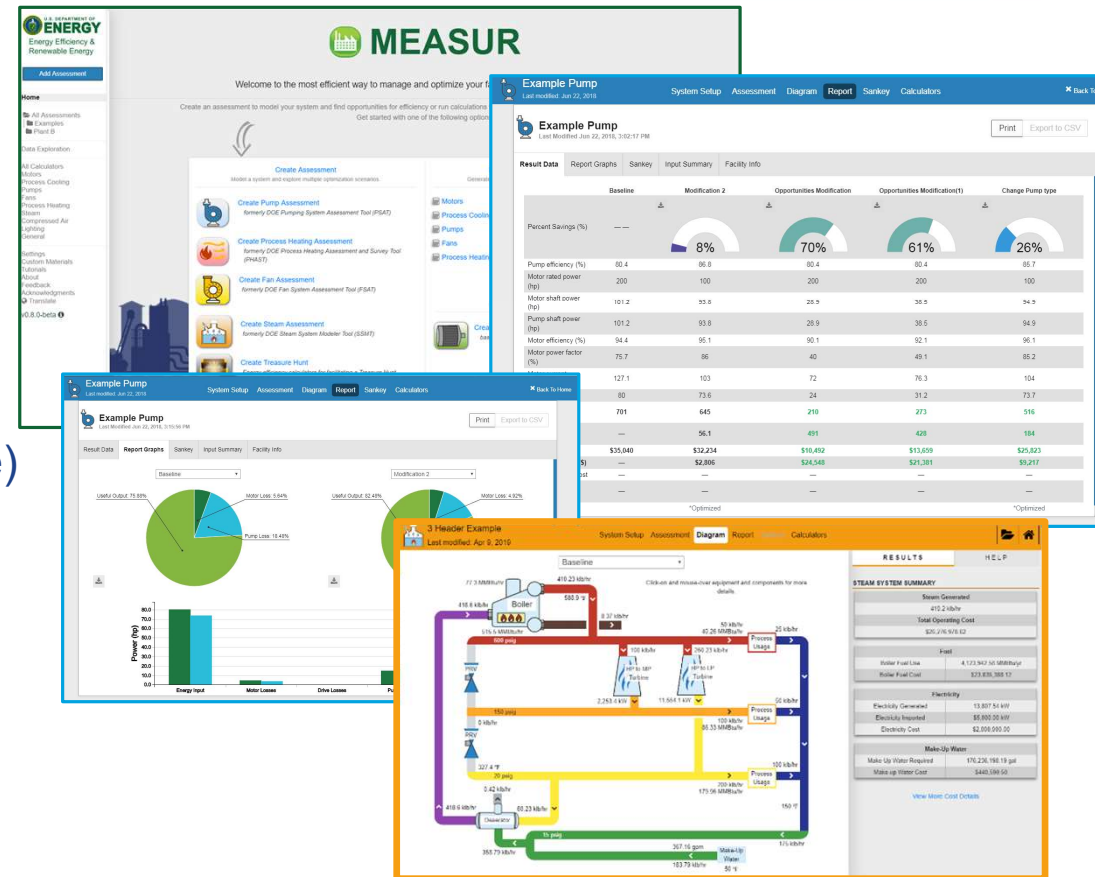
- GitHub repository:  
<https://github.com/ORNL-AMO>
- Download:  
<https://www.energy.gov/eere/amo/measur>
- All code suggestions approved by team

### ■ Designed for Multiple Operating Systems (Windows, Mac, Linux, Online)

- Common software engine library
- Automatic update notification

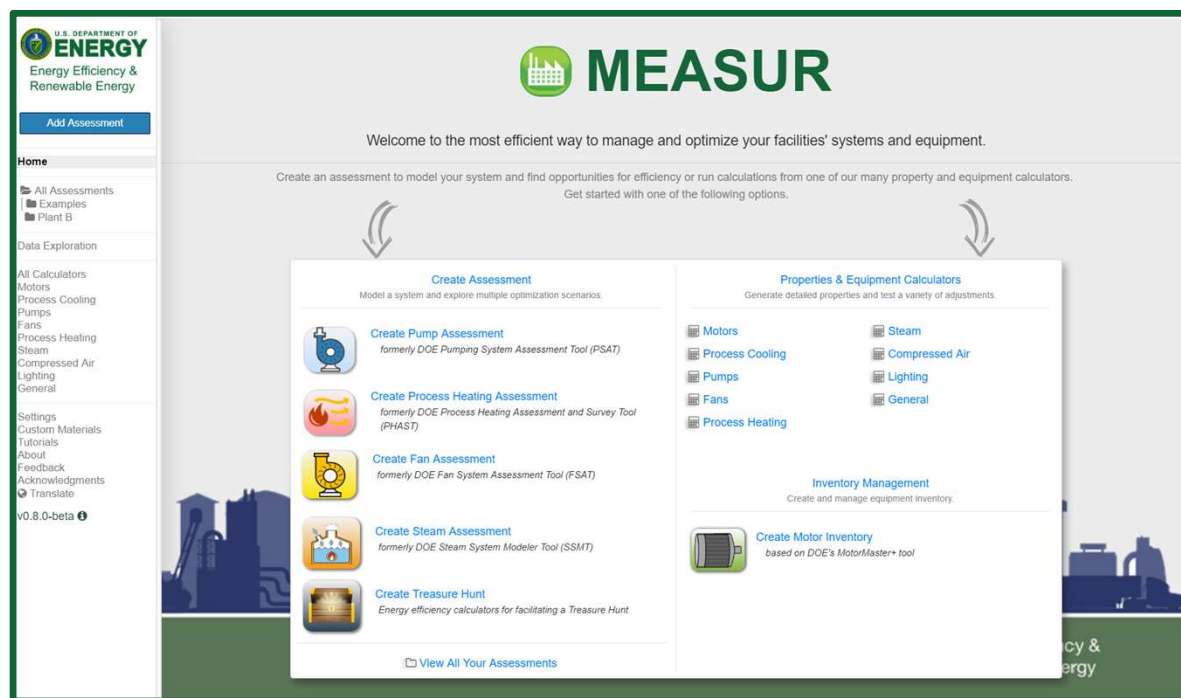
## ■ Without sacrifice

- Still technology/vendor agnostic
- Using established algorithms with updates from experts



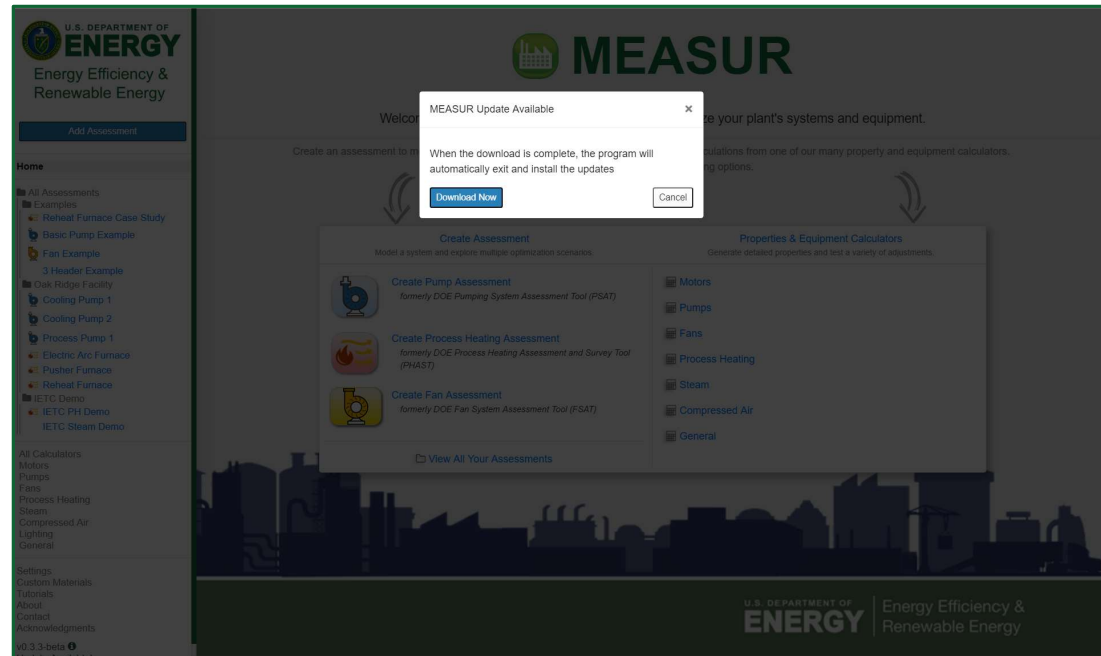
# Manufacturing Energy Assessment Software for Utility Reduction - MEASUR

- Model manufacturing energy use and generation
- 6 Assessment types
  - Pumps, fans, process heating, steam, treasure hunt – Beta
  - Compressed air – In Progress
- Inventory
  - Motors – Beta
  - Pumps, fans, compressed air, maintenance - planning
- 50+ Stand alone Calculators
  - Pumps, fans, heating, steam, compressed air, motors, lighting, CHP, etc.



# Download via DOE-EERE- AMO website

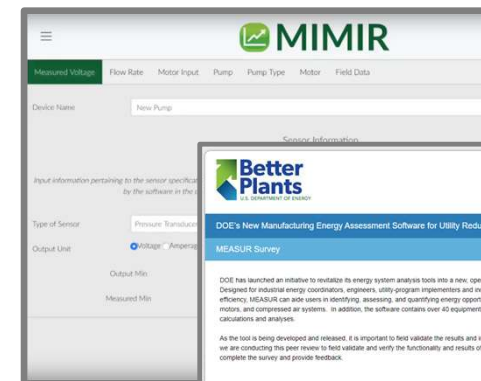
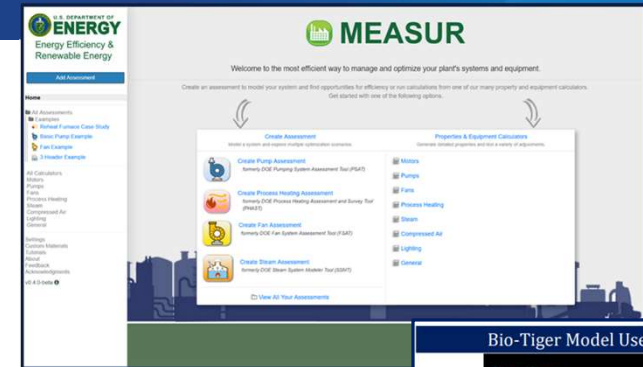
- <https://www.energy.gov/eere/amo/measur>
- This Tool is in **beta**, updates will occur often
- Automatic notification of update (if connected to internet)
  - **DO NOT UNINSTALL** before updating, you will lose **ALL** your assessments within the tool.



Or Google: AMO Software Tools

# Engagement!

- Contribute
  - GitHub repository: <https://github.com/ORNL-AMO>
  - Dr. Moore's Bio-Tiger Model
  - TN Tech's MIMIR
- Download
  - [www.energy.gov/eere/amo/measur](http://www.energy.gov/eere/amo/measur)
- Feedback
  - <https://www.surveymonkey.com/r/DOE-AMO-TOOLS>



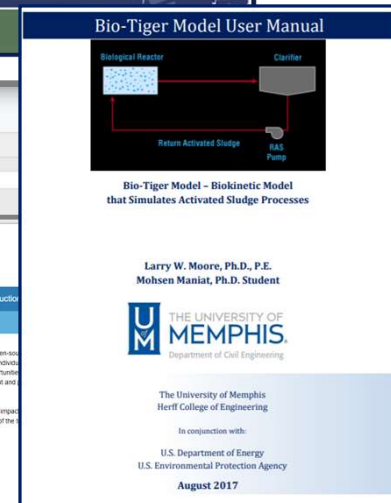
1. Your Name

2. Your Organization:

3. Your email address?

4. Your Phone Number?

5. What is your principal business type?



## Polls

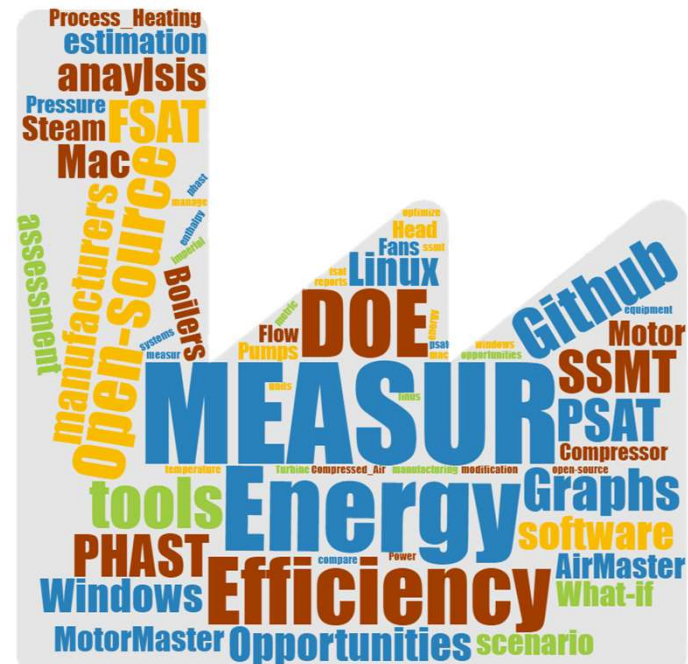
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Tell us about you!

Please go to [www.slido.com](http://www.slido.com) and enter code **#DOE** to respond

# MEASUR Demo

# Using MEASUR





# Getting Started

- ➡ Start an assessment
- ➡ Create an inventory
- ➡ View Assessment Dashboard
- ➡ Use Properties & Equipment Calculators
- ➡ Help and User Experience
  - Change Settings
  - View Tutorials
  - Manage Custom Materials
  - Provide Feedback
  - Translate

The screenshot shows the MEASUR web application interface. The header includes the U.S. Department of Energy logo and the MEASUR title. A welcome message states: "Welcome to the most efficient way to manage and optimize your facilities' systems and equipment. Create an assessment to model your system and find opportunities for efficiency or run calculations from one of our many property and equipment calculators. Get started with one of the following options." The interface is divided into several sections:

- Left Sidebar:** Contains navigation links: Home, All Assessments (with sub-links for Examples and Plant B), Data Exploration, All Calculators (listing Motors, Process Cooling, Pumps, Fans, Process Heating, Steam, Compressed Air, Lighting, and General), Settings (listing Custom Materials, Tutorials, About, Feedback, Acknowledgments, and Translate), and version information (v0.8.0-beta).
- Central Panel:** Titled "Create Assessment", it lists several options: Create Pump Assessment (formerly DOE Pumping System Assessment Tool (PSAT)), Create Process Heating Assessment (formerly DOE Process Heating Assessment and Survey Tool (PHAST)), Create Fan Assessment (formerly DOE Fan System Assessment Tool (FSAT)), Create Steam Assessment (formerly DOE Steam System Modeler Tool (SSMT)), and Create Treasure Hunt (Energy efficiency calculators for facilitating a Treasure Hunt).
- Right Panel:** Titled "Properties & Equipment Calculators", it lists: Motors, Process Cooling, Pumps, Fans, Process Heating, Steam, Compressed Air, Lighting, and General. Below this is the "Inventory Management" section, which includes "Create Motor Inventory" (based on DOE's MotorMaster+ tool).

Colored arrows indicate the flow from the list on the left to the corresponding sections in the application: a blue arrow from "Start an assessment" to the "Create Assessment" panel; a green arrow from "Create an inventory" to the "Inventory Management" section; a red arrow from "View Assessment Dashboard" to the "All Assessments" link in the sidebar; a yellow arrow from "Use Properties & Equipment Calculators" to the "Properties & Equipment Calculators" panel; and an orange arrow from "Help and User Experience" to the "Settings" section in the sidebar.



# Settings

- Set global units & utility costs
- Change language
  - MUST be connected to internet
- Turn on/off Tutorials
- Clear Data

### General Settings

These will be default settings for any new assessments and folders.

Language [Translate Application Using Google Translate](#)

Currency

Units of Measure ☒ Imperial ☐ Metric

Energy Result Unit

Default Panel Tab ☒ Results ☐ Help

Energy Costs for Operation

Fuel	<input type="text" value="3.99"/>	<input type="text" value="\$/MMBtu"/>
Steam (as utility)	<input type="text" value="4.69"/>	<input type="text" value="\$/kib"/>
Electricity	<input type="text" value="0.066"/>	<input type="text" value="\$/kWh"/>
Compressed Air (as utility)	<input type="text" value="0.022"/>	<input type="text" value="\$/SCF"/>
Other Fuel	<input type="text" value="0"/>	<input type="text" value="\$/MMBtu"/>
Water	<input type="text" value="0"/>	<input type="text" value="\$/gal"/>
Waste Water	<input type="text" value="0"/>	<input type="text" value="\$/gal"/>

Pump Settings

Process Heating Settings

Fan Settings

Steam Settings

Tutorial Settings

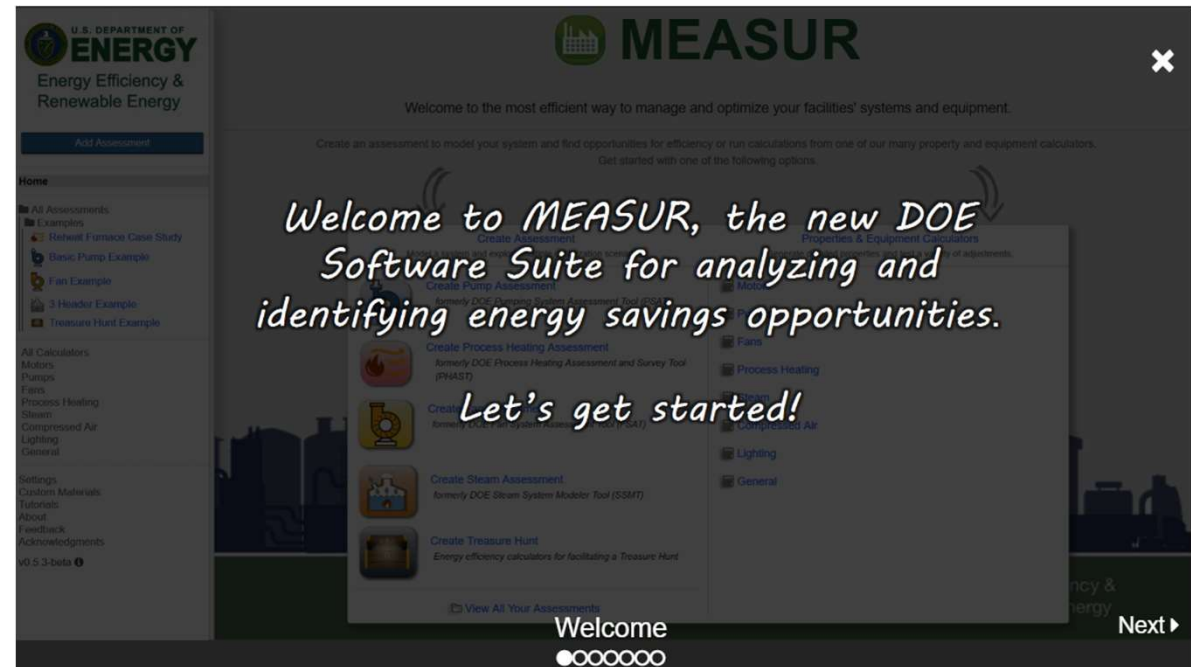
### Restore System Settings

Restoring system settings will provide options for resetting all application settings to their default values, returning all example assessments to their original state, deleting all user-created assessments/pre-assessments, and deleting all user-created materials. **This cannot be undone!**

Restore System Settings

# Tutorials & Feedback

- View all Tutorials
- Let us know if you like MEASUR!
  - [Survey](#)
- Bug Reporting
  - Email
    - [accawigk@ornl.gov](mailto:accawigk@ornl.gov)
    - [armstrongko@ornl.gov](mailto:armstrongko@ornl.gov)
  - Download full Data set
    - This will help us identify the problem
  - Screenshots please



# Dashboard - Overview

View all your assessments in a folder-based organization

The screenshot displays the 'All Assessments / Plant B' dashboard. The interface includes a sidebar with navigation options like 'Add Assessment', 'All Assessments', and 'Data Exploration'. The main content area shows a summary table for Plant B, a 'PLANT B PRE-ASSESSMENT' section, and several detailed assessment cards for different equipment types.

**PLANT B SUMMARY**

Type	Assessments	Annual Energy Used	Annual Energy Cost
Pumps	3	6,508.68 MWh	\$373,614.00
Process Heating	3	2,753,210 MMBtu	\$21,766,724.55
Fans	2	15,659.6 MWh	\$939,573.03
Steam	0	0.00000 MMBtu	\$0.00
<b>Total</b>	<b>8</b>	<b>2,753,210 MMBtu</b>	<b>\$23,079,911.58</b>

**PLANT B PRE-ASSESSMENT**

Add Pre-Assessment / Screening

No Pre-Assessment found for this facility.

**PLANT B INFO**

Company: A Company Facility: Plant B Date: 9/16/2020

**PLANT B SETTINGS**

Units of Measure	Imperial
Fuel Cost	\$3.99/MMBtu
Steam Cost	\$4.69/MMBtu
Electricity Cost	\$0.07/kWh

**PLANT B MOTORS**

Inventory Summary:

Number of Departments:	2
Number of Motors:	10
Annual Energy Use:	13,706,283 kWh/yr
Annual Energy Cost:	\$904,615

**ELECTRIC ARC FURNACE**

Furnace Type: Electric Arc Furnace (EAF)

Baseline Data:

Annual Energy Use:	165,017.656 kWh
Annual Energy Costs:	\$10,891,165

**PUSHER FURNACE**

Furnace Type: Pusher Furnace

Baseline Data:

Annual Energy Use:	74,450 MMBtu
Annual Energy Costs:	\$297,056

**REHEAT FURNACE**

Furnace Type: Reheat Furnace

Baseline Data:

Annual Energy Use:	2,115,701 MMBtu
Annual Energy Costs:	\$10,578,503

**HVAC FAN**

Baseline Data:

Annual Energy Use:	3,942 MWh
Annual Energy Costs:	\$236,520

**COAL DRYER**

Baseline Data:

Annual Energy Use:	11,719 MWh
Annual Energy Costs:	\$703,063

**PROCESS PUMP 1**

Baseline Data:

Annual Energy Use:	4,819 MWh
Annual Energy Costs:	\$305,680

**COOLING PUMP 2**

Baseline Data:

Annual Energy Use:	990 MWh
Annual Energy Costs:	\$69,494

- ➡ Move, copy, import and export assessments
- ➡ Add/view facility information and folder-wide settings
- ➡ Make pre-assessment screenings
- ➡ Generate rollup reports of several assessments
- ➡ Add New Assessment
- ➡ Add New Inventory

# Dashboard – Folders are Facilities

The Dashboard is designed to treat each folder like a facility or business unit

Dashboard interface for Plant B:

Sort By: Last Updated | Filter | [Icons]

Buttons: Add Assessment, Add Pre-Assessment, Add Folder, Add Inventory, Generate Report, Select all folder content, Delete, Export, Import

**PLANT B INFO**

Company: A Company	Facility: Plant B	Date: 9/16/2020
Assessment Contact: K. Armstrong	Facility Contact: S. Body	Address: 789 A Street, Anytown, TN 37830, USA
armstrongko@ornl.gov	sbody@companyA.com	<a href="#">Hide Details</a> <a href="#">Edit Info</a>

**PLANT B SUMMARY**

Type	Assessments	Annual Energy Used	Annual Energy Cost
Pumps	3	6,508.68 MWh	\$373,614.00
Process Heating	3	2,753,210 MMBtu	\$21,766,724.55
Fans	2	15,659.6 MWh	\$939,573.03
Steam	0	0.00000 MMBtu	\$0.00
Total	8	2,753,210 MMBtu	\$23,079,911.58

**PLANT B SETTINGS**

Units of Measure	Imperial
Fuel Cost	\$3.99 /MMBtu
Steam Cost	\$4.69 /MMBtu
Electricity Cost	\$0.07 /kWh

[Edit Settings](#)

Plant B Facility Information.

Company Name: A Company | Facility Name: Plant B

Assessment Date: 9/16/2020

**Facility Contact Info**

Name: S. Body | Name: K. Armstrong

Phone Number: | Phone Number: |

Email: sbody@companyA.com | Email: armstrongko@ornl.gov

**Facility Location**

Street: 789 A Street | City: Anytown

State: TN | Zip: 37830

Country: USA

Quick Summary of all assessments in folder

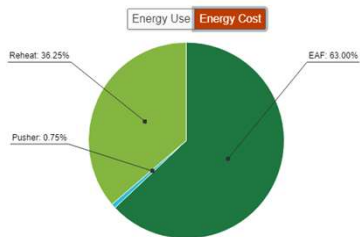
Enter information about facility. This will appear in reports

Set units and utility costs for any NEW assessments created

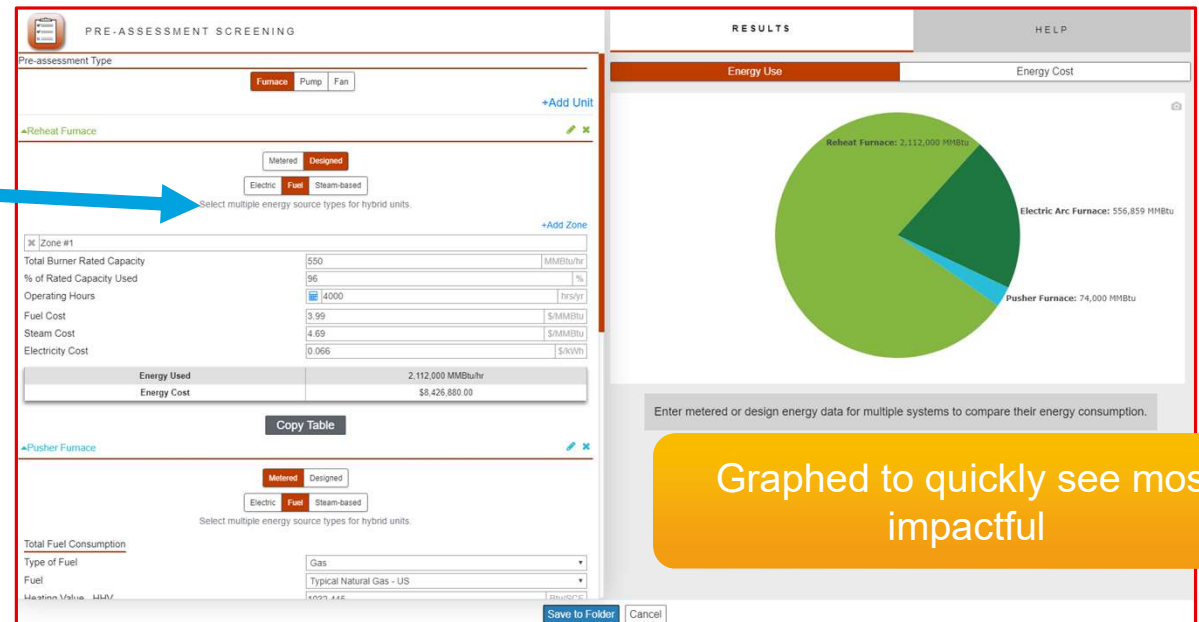
# Dashboard - Pre-Assessments

Pre-Assessments are to help you triage equipment to best utilize assessment time

Enter either design specifications or meter data to determine your priorities



Switch between Energy Use and Cost if equipment uses different fuel



Graphed to quickly see most impactful

# Dashboard - Rollup Reports

Create Rollup Reports to see the impacts of opportunities on overall energy use

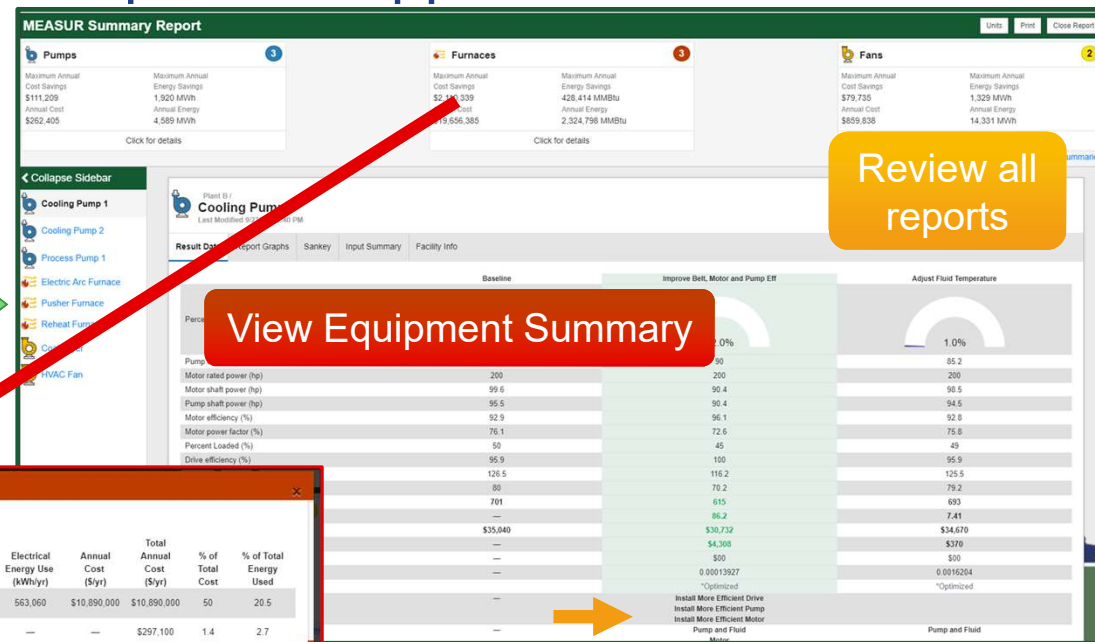
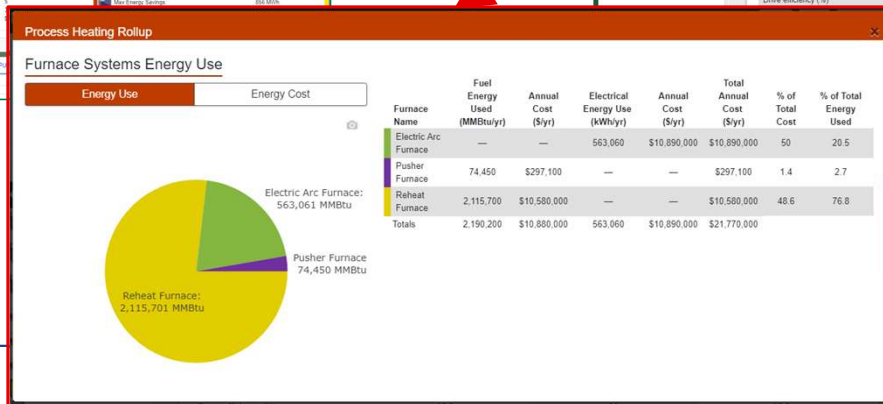
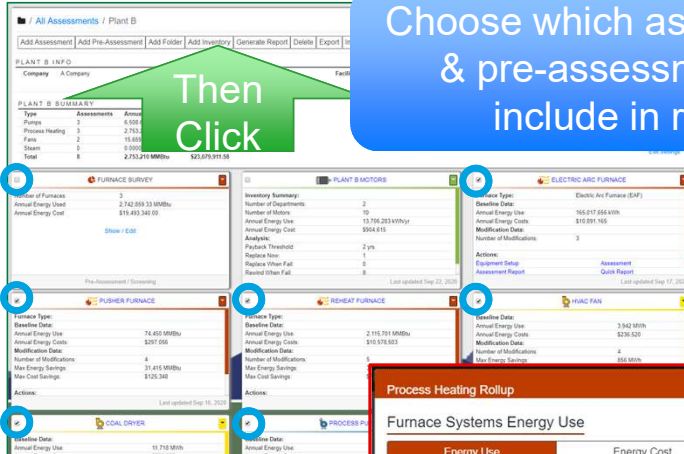
Choose which assessments & pre-assessments to include in rollup

Then Click

Review all reports

View Equipment Summary

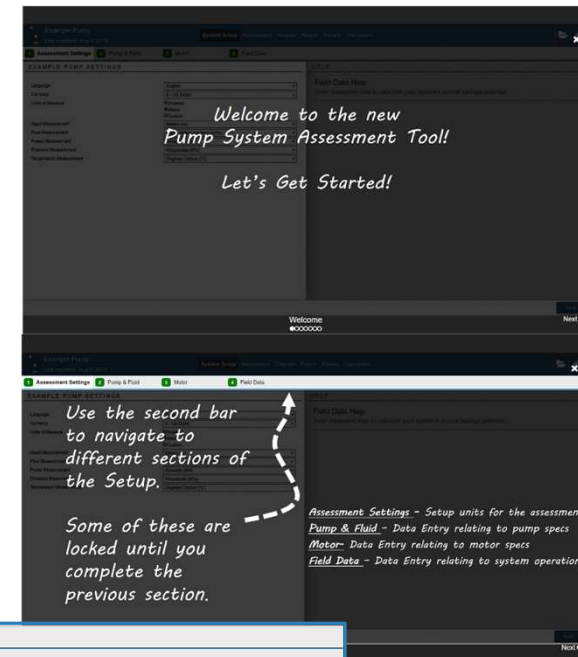
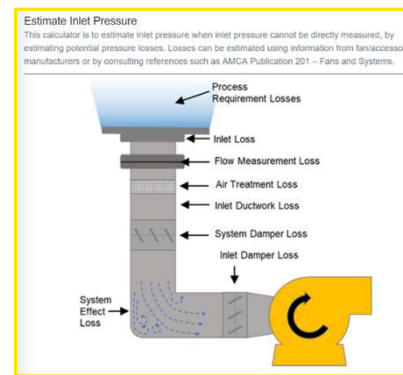
Choose which scenario to include





# Key Features - Help Text & Tutorials

- Tutorials
  - Help to get started using tool
- Help text for each data entry field
  - Diagrams to help understand where to obtain data
  - Can switch between help or results being shown by default



RESULTS

HELP

**Charge Material Help**  
Enter measured data to calculate your system's annual savings potential.

**Savings Suggestions**  
Explore possibilities of lowering the final product temperature  
Preheating the charge or load material entering the furnace  
Pre-drying to reduce moisture content of the load entering the furnace  
Maintain charge feed rate as close to the rated capacity as possible  
Consider possibility of reducing endothermic reactions by controlling process conditions

Note: These energy saving measures are for guidance only. Not all measures are applicable under all operating conditions. There may additional measures when considering specific situations and the user is encouraged to review and apply the appropriate measures

HELP

**Motor Help**  
Enter measured data to calculate your system's annual savings potential.

**Motor RPM**  
Motor RPM is the nameplate speed of the motor.  
This value is used with the line frequency to determine the number of motor poles. This, in turn, is used (along with motor class and size) to estimate motor efficiency and output shaft power for the measured electrical power or current conditions.

Efficiency Class	Line Frequency	Minimum	Maximum
Standard Efficient	60 Hz	540 rpm	3600 rpm
Standard Efficient	50 Hz	450 rpm	3000 rpm
Energy Efficient	60 Hz	540 rpm	3600 rpm
Energy Efficient	50 Hz	450 rpm	3000 rpm
Premium Efficient	60 Hz	1080 rpm	3600 rpm
Premium Efficient	50 Hz	900 rpm	3000 rpm

# Key Features – Customize Units & Notes

- Units are easily customizable and can be changed after data entry!
- Add notes on assessment conditions to add to report

Charge (wet)-Feed Rate 4226 lb/hr



1 Assessment Settings 2 Heat Balance 3 Aux Equipment 4 Design Energy Use 5 Metering

REHEAT FURNACE 2 SETTINGS

Your units have changed! Click here to update your data to reflect these changes!

Language	English
Currency	\$ - US Dollar
Units of Measure	<input type="radio"/> Imperial <input checked="" type="radio"/> Metric
Energy Result Unit	Gigajoules (GJ)

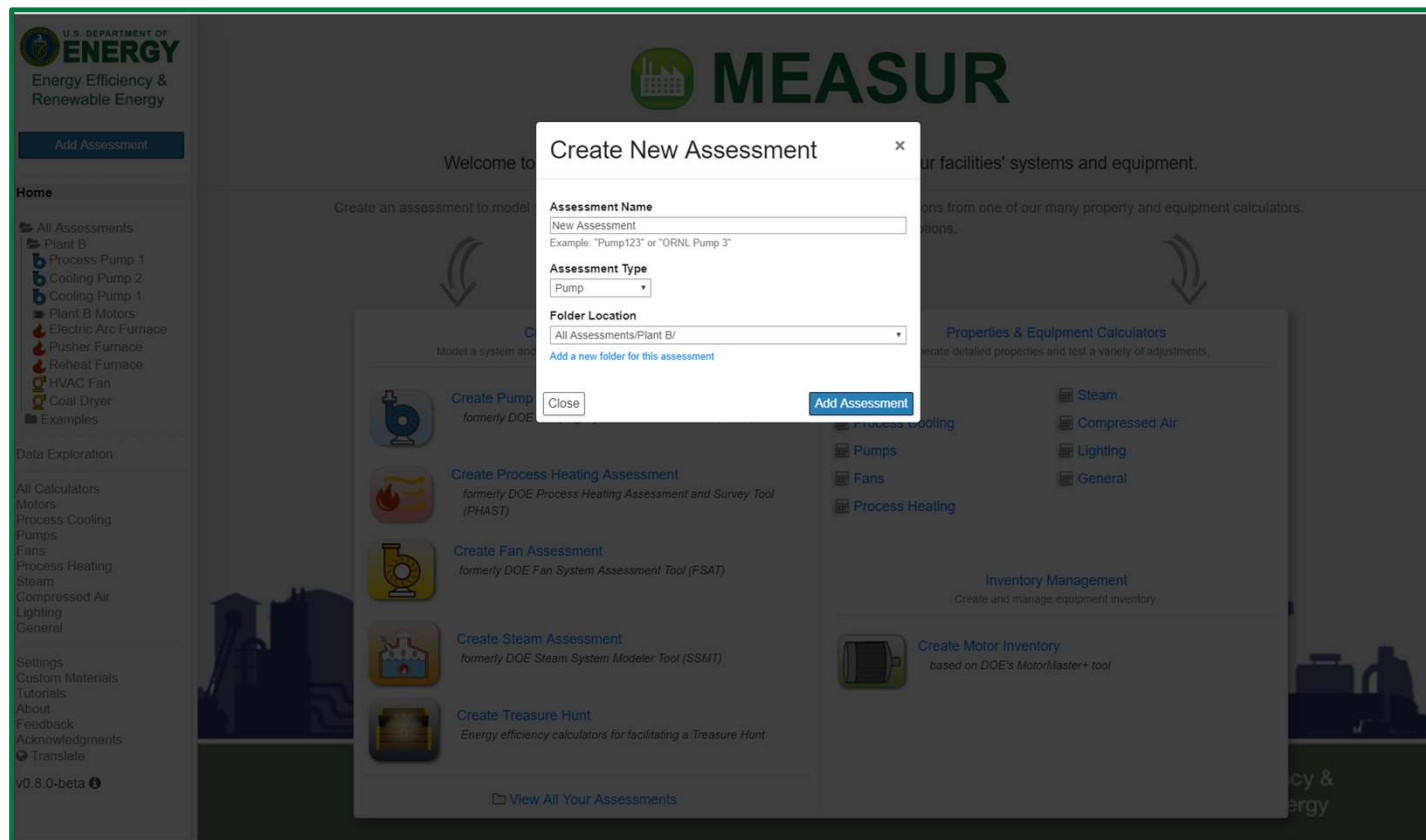


Charge (wet)-Feed Rate 1916.8798 kg/hr

Can also change unit settings for all new assessments in global settings or in the dashboard



# Starting an Assessment



- Choose a unique name for the assessment
- Set Assessment type (Pump, Fan, Process Heater, Steam, Treasure Hunt)
- Choose folder location
  - Or make a new folder

# System Setup

**Reheat Furnace Case Study**  
Fuel-fired

System Setup Assessment Diagram

1 Assessment Settings 2 Heat Balance 3 Aux Equipment 4 Design Energy Use 5 Diagrams

REHEAT FURNACE CASE STUDY SETTINGS

Language: English  
Currency: \$ - US Dollar  
Units of Measure: Imperial  
Energy Result Unit: Millions British Thermal Units (MMBtu)  
Select Energy Source Type: Fuel-fired  
Common Result Unit: Millions British Thermal Units (MMBtu)  
Common Fuel Unit: Millions British Thermal Units (MMBtu)  
Common Electricity Unit: Kilowatt-hours (kWh)  
Common Steam Unit: Millions British Thermal Units (MMBtu)

EQUIPMENT NOTES  
Add additional information for your equipment

OPERATING CONDITIONS AT TIME OF ASSESSMENT  
The furnace was running at the full load capacity during the PH assessment.

Start with current equipment and operations -  
Baseline

**Fan Example**  
Last modified: Aug 28, 2016

System Setup Assessment Diagram Report Sankey Calculators

1 Assessment Settings 2 Fluid 3 Fan 4 Motor 5 Field Data

MOTOR

Line Frequency: 60 Hz  
Rated Motor Power: 600 hp  
Motor RPM: 1150  
Efficiency Class: Energy Efficient  
Rated Voltage: 480  
Full Load Amps: 683.25

Motor Help  
Enter measured data to calculate your system's annual savings potential.

Motor RPM  
Motor RPM is the nameplate speed of the motor.

This value is used with the line frequency to determine the number of motor poles. This, in turn, is used (along with motor class and size) to estimate motor efficiency and output shaft power for the measured electrical power or current conditions.

Standard and Energy Efficient Motors

Motor Size	Minimum	Maximum
60 Hz	540 rpm	3600 rpm
50 Hz	450 rpm	3000 rpm

Premium Efficient Motors

Motor Size	Minimum	Maximum
60 Hz	1080 rpm	3600 rpm
50 Hz	900 rpm	3000 rpm

- Assessment Settings: Set units and basic assessment settings
- Assessment Specific Tabs
  - Data Entry for baseline assessment
  - Intermediate Results
  - Help text for each data entry field

# Assessments

## Explore energy savings opportunities

**Cooling Pump 2**  
Last modified: Sep 23, 2020

System Setup | **Assessment** | Diagram | Report | Sankey | Calculators

**Explore Opportunities** | Modify All Conditions

Select potential adjustment projects to explore opportunities to increase efficiency and the effectiveness of your system.

**Modify All Conditions**

Modification Name: Improve Belt, Motor and Pump Eff

**RESULTS**

Baseline	Improve Belt, Motor and Pump Eff
Percent Savings (%)	32.0%
Pump efficiency (%)	88.7
Motor rated power (hp)	200
Motor shaft power (hp)	99.9
Pump shaft power (hp)	99.9
Motor efficiency (%)	96.4
Motor power factor (%)	74.9
Percent Loaded (%)	69
Motor current (amps)	124.2
Motor power (kW)	77.2
Annual Energy (MWh)	877
Annual Energy Savings (MWh)	215
Annual Cost	\$33,864
Annual Savings	\$16,630

**Process Heating - Fuel Example**  
Fuel-fired  
Last modified: Sep 23, 2020

System Setup | **Assessment** | Diagram | Report | Sankey | Calculators

**Modify All Conditions**

**BASELINE**

Operating Hours	6912
Fuel Costs	\$
Steam Costs	\$
Electricity Costs	0.05

**ALL OPPORTUNITIES**

Operating Hours	6912
Fuel Costs	\$
Steam Costs	\$
Electricity Costs	0.05
Implementation Cost	\$

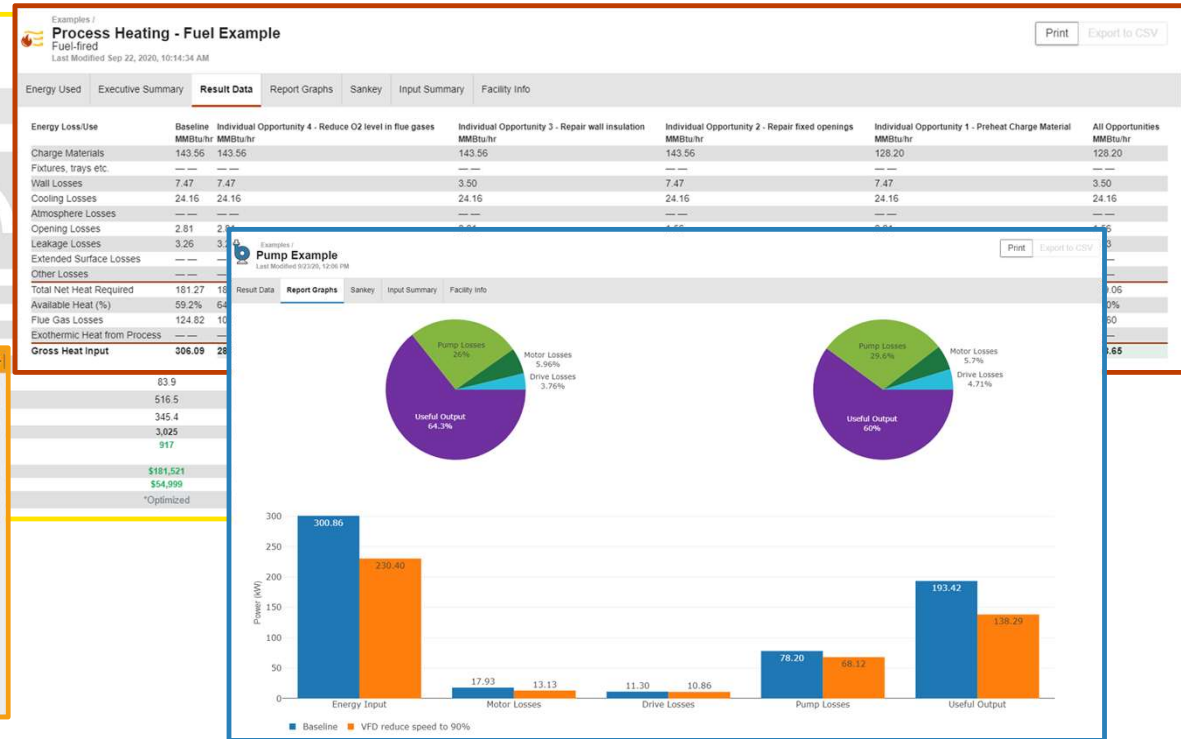
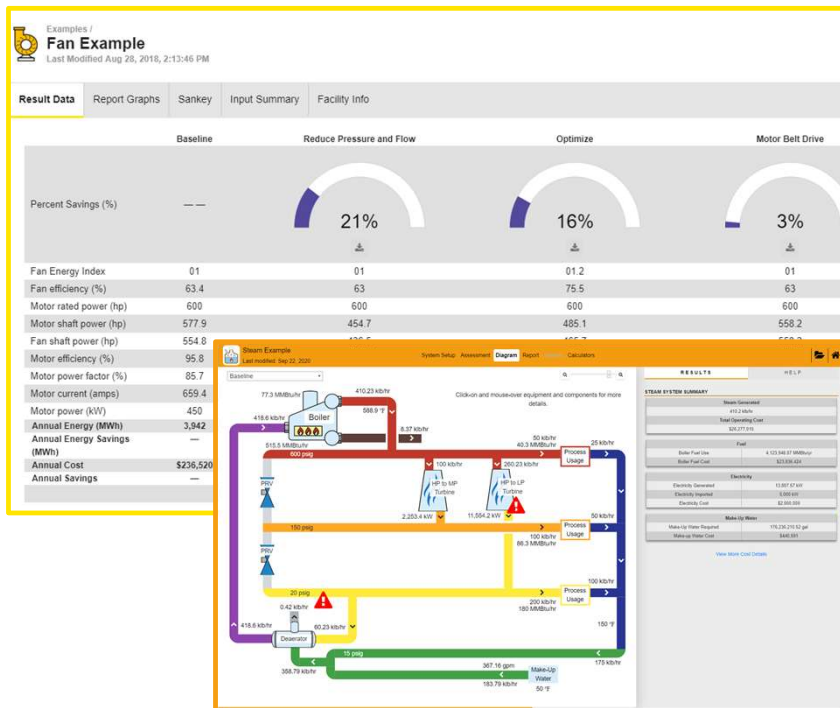
**RESULTS**

Energy Loss/Use	Baseline	All Opportunities
Charge Materials	143.56	128.20
Fixtures, trays etc.	---	---
Wall Losses	7.47	3.50
Cooling Losses	24.16	24.16
Atmosphere Losses	2.81	1.56
Leakage Losses	3.26	1.63
Extended Surface Losses	---	---
Other Losses	---	---
Total Net Heat Required	181.27	159.06
Available Heat (%)	59.2%	64.0%
Flue Gas Losses	124.82	89.60
Exothermic Heat from Process	---	---
Gross Heat Input	306.09	248.65

- Explore Opportunities: build scenarios from pre-established energy savings measures
- Modify All Conditions: build scenarios using same forms as baseline
  - Badges and field highlighting for visual cues

# Reports

View side-by-side comparison of all scenarios and graphs for data visualization



# Reports - Printing

## Print to PDF for Assessment Reports & Rollup Reports

Examples /  
**Process Heating - Fuel Example**  
Fuel-fired  
Last Modified Sep 22, 2020, 10:14:34 AM

Energy Used

Executive Summary

**Result Data**


Report Graphs

Sankey

Input Summary

Facility Info

Energy Loss/Use	Baseline MMBtu/hr	Individual Opportunity 4 - Reduce O2 level in flue gases MMBtu/hr	Individual Opportunity 3 - Repair wall insulation MMBtu/hr	Individual Opportunity 2 - Repair fixed openings MMBtu/hr	Individual Opportunity 1 - Preheat Charge Material MMBtu/hr	All Opportunities MMBtu/hr
Charge Materials	143.56	143.56	143.56	143.56	128.20	128.20
Fixtures, trays etc.	---	---	---	---	---	---
Wall Losses	7.47	7.47	3.50	7.47	3.50	3.50
Cooling Losses	24.16	24.16	24.16	24.16	24.16	24.16
Atmosphere Losses	---	---	---	---	---	---
Opening Losses	2.81	2.81	2.81	1.56	2.81	1.56
Leakage Losses	3.26	3.26	3.26	3.26	1.63	1.63
Extended Surface Losses	---	---	---	---	---	---
Other Losses	---	---	---	---	---	---
Total Net Heat Required	181.27	181.27	165.91	159.06	155.91	155.91
Available Heat (%)	59.2%	64.0%	59.2%	64.0%	59.2%	64.0%
Flue Gas Losses	124.82	102.11	114.25	89.60	114.25	89.60
Exothermic Heat from Process	---	---	---	---	---	---
Gross Heat Input	306.09	283.38	280.15	248.65	280.15	248.65



**Energy Assessment  
Summary Report**  
May 22, 2019, 5:02:39 PM

**ASUR Summary Report**

Print

Export to CSV

Compress Sidebar

Rollup Summary

**Pumps**

Maximum Annual Energy Savings  
\$2,110,339  
Annual Energy  
4,589 MMBtu

**Furnaces**

Maximum Annual Energy Savings  
\$2,110,339  
Annual Energy  
4,589 MMBtu

**Fans**

Maximum Annual Energy Savings  
\$79,735  
Annual Energy  
14,331 MMBtu

**Cooling Pump 1**

Result Data

Report Graphs

Sankey

Input Summary

Facility Info

	Baseline	Improve Belt, Motor and Pump Eff	Adjust Fluid Temperature
Percent Savings (%)	---	12.0%	1.0%
Pump efficiency (%)	85.2	90	85.2
Motor rated power (hp)	200	200	200
Motor shaft power (hp)	99.6	96.4	96.5
Pump shaft power (hp)	96.5	96.4	96.5
Motor efficiency (%)	92.9	96.1	92.8
Motor power factor (%)	76.1	72.6	75.8
Percent Loaded (%)	50	45	49
Drive efficiency (%)	95.9	100	95.9
Motor current (amps)	126.5	116.2	125.5
Motor power (kW)	80	70.2	79.2
Annual Energy (MMWh)	791	695	695
Annual Energy Savings (MMWh)	---	96.2	7.41
Annual Cost (\$)	\$75,049	\$30,732	\$34,679
Annual Savings (\$)	---	\$4,308	\$370
Implementation Cost	---	\$00	\$00
Payback Period (months)	---	0.00013627	0.0016204
Selected Energy Projects	---	Install More Efficient Drive Install More Efficient Motor Pump and Fluid Motor	Optimized
Modifications	---	---	Pump and Fluid Motor

# Assessments

- 5 different assessment types
  - Pumps
  - Process Heating
  - Fans
  - Steam System
  - Treasure Hunt

The screenshot shows the MEASUR web application interface. On the left is a sidebar with the U.S. Department of Energy logo and navigation links: Home, All Assessments, Examples, Plant B, Data Exploration, All Calculators, Motors, Process Cooling, Pumps, Fans, Process Heating, Steam, Compressed Air, Lighting, General, Settings, Custom Materials, Tutorials, About, Feedback, Acknowledgments, Translate, and v0.8.0-beta. The main content area features the MEASUR logo and a welcome message. Below this, there are two main sections: 'Create Assessment' and 'Properties & Equipment Calculators'. The 'Create Assessment' section is highlighted with a blue box and contains five options: 'Create Pump Assessment' (formerly DOE Pumping System Assessment Tool (PSAT)), 'Create Process Heating Assessment' (formerly DOE Process Heating Assessment and Survey Tool (PHAST)), 'Create Fan Assessment' (formerly DOE Fan System Assessment Tool (FSAT)), 'Create Steam Assessment' (formerly DOE Steam System Modeler Tool (SSMT)), and 'Create Treasure Hunt' (Energy efficiency calculators for facilitating a Treasure Hunt). The 'Properties & Equipment Calculators' section lists various calculators: Motors, Process Cooling, Pumps, Fans, Process Heating, Steam, Compressed Air, Lighting, and General. Below this is an 'Inventory Management' section with a 'Create Motor Inventory' option based on DOE's MotorMaster+ tool. At the bottom of the main content area is a link to 'View All Your Assessments'.

# Pumps

Pump Example  
Last modified: Sep 23, 2020

System Setup **Assessment** Diagram Report Sankey Calculators

Explore Opportunities **Modify All Conditions**  
Novice View Expert View

Pump Fluid Motor Field Data

**BASELINE**

Line Frequency	60 Hz
Rated Motor Power	350.01 hp
Motor RPM	2000 rpm
Efficiency Class	Standard Efficiency
Rated Voltage	460 V
Full-Load Amps	172.63 A

Inputs to this calculated value have changed. Consider re-estimating.

**NEW PUMP AND MOTOR**

Line Frequency	60 Hz
Rated Motor Power	350 hp
Motor RPM	2000 rpm
Efficiency Class	Premium Efficient
Rated Voltage	460 V
Full-Load Amps	176.85 A

**RESULTS**

	Baseline	New Pump and Motor
Percent Savings (%)	—	20.0%
Pump efficiency (%)	71.2	87.5
Motor rated power (hp)	350	350
Motor shaft power (hp)	379.3	308.6
Pump shaft power (hp)	364.1	296.2
Motor efficiency (%)	94	96.1
Motor power factor (%)	201.9	90.2
Percent Loaded (%)	108	88
Drive efficiency (%)	96	96
Motor current (amps)	187	333.6
Motor power (kW)	300.9	239.6
Annual Energy (MWh)	2,636	2,099
Annual Energy Savings (MWh)	—	537
Annual Cost	\$173,943	\$138,526
Annual Savings	—	\$35,417

Back View Report

Pump Example  
Last modified: Sep 23, 2020

System Setup **Assessment** Diagram Report Sankey Calculators

Explore Opportunities **Modify All Conditions**  
Novice View Expert View

**NEW PUMP AND MOTOR**  
Selected Scenario View / Add Scenario

**SELECT POTENTIAL ADJUSTMENT PROJECTS**  
Select potential adjustment projects to explore opportunities to increase efficiency and the effectiveness of your system.

**Modify Name** New Pump and Motor

☐ Install VFD

☐ Install More Efficient Drive

☒ Install More Efficient Pump

Baseline Pump Type: End Suction ANSI/API  
Modification Pump Type: End Suction ANSI/API  
Modification Pump Efficiency: 87.52 %  
Known Efficiency

The efficiency of your pump has been calculated based on your flow rate and selected pump type. Click "Known Efficiency" to use the efficiency calculated by your system setup.

☐ Reduce System Flow Rate

☐ Reduce System Head Requirement

☐ Adjust Operational Data

☒ Install More Efficient Motor

Baseline Efficiency Class: Standard Efficiency  
Modification Efficiency Class: Premium Efficient

**RESULTS**

	Baseline	New Pump and Motor
Percent Savings (%)	—	20.0%
Pump efficiency (%)	71.2	87.5
Motor rated power (hp)	350	350
Motor shaft power (hp)	379.3	308.6
Pump shaft power (hp)	364.1	296.2
Motor efficiency (%)	94	96.1
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Annual Savings	—	\$35,417

Back View Report

- Compute motor full load amps, load current and power factor, fluid head, and fan and motor efficiency
- Explore the savings from changing pump and motor efficiency (which can be optimized automatically), flow and head, or even fluid temperature



# Process Heating

Process Heating - Fuel Example  
Fuel-fired  
Last modified: Sep 23, 2020

System Setup **Assessment** Diagram Report Sankey Calculators

Explore Opportunities **Modify All Conditions**  
Novice View Expert View

Operations ☒ Charge Materials ☒ Flue Gas ☒ Fixture Wall ☒ Cooling ☒ Atmosphere Opening ☒ Leakage ☒ Extended Surface Other

BASELINE		ALL OPPORTUNITIES	
Operating Hours	6912 hrs/yr	Operating Hours	6912 hrs/yr
Fuel Costs	5 \$/MMBtu	Fuel Costs	5 \$/MMBtu
Steam Costs	8 \$/MMBtu	Steam Costs	8 \$/MMBtu
Electricity Costs	0.05 \$/kWh	Electricity Costs	0.05 \$/kWh
		Implementation Cost	5

RESULTS		
Energy Loss/Use	Baseline MMBtu/hr	All Opportunities MMBtu/hr
Charge Materials	143.56	128.20
Fixtures, trays, etc.	---	---
Wall Losses	7.47	3.50
Cooling Losses	24.16	24.16
Atmosphere Losses	---	---
Opening Losses	2.61	1.56
Leakage Losses	3.26	1.63
Extended Surface Losses	---	---
Other Losses	---	---
Total Net Heat Required	181.27	159.06
Available Heat (%)	59.2%	64.0%
Flue Gas Losses	124.62	89.60
Exothermic Heat from Process	---	---
Gross Heat Input	306.09	248.65

Back Next View Report

Process Heating - Fuel Example  
Fuel-fired  
Last modified: Sep 23, 2020

System Setup **Assessment** Diag

Explore Opportunities **Modify All Conditions**  
Novice View Expert View

SELECT POTENTIAL ADJUSTMENT PROJECTS  
Select potential adjustment projects to explore opportunities to increase efficiency and the effectiveness of your system.

**Add New Scenario**

Modification Name: All Opportunities

☒ Maintain Optimum Air/Fuel Ratio or Recommended O<sub>2</sub> Level in Flue Gas

Baseline	Modifications
Oxygen Calculation Method	Oxygen Calculation Method
Oxygen in Flue Gas	Oxygen in Flue Gas
Oxygen in Flue Gas	Oxygen in Flue Gas
6%	2 %
Excess Air in Flue Gas	Excess Air in Flue Gas
36.52 %	09.90 %

☐ Preheat Combustion Air

☒ Preheat Charge Material

☒ Modify Initial Temperature: Material #1

Baseline	Modifications
Initial Temperature	Initial Temperature
60 °F	300 °F

☒ Control and Optimize Furnace Pressure

☐ Modify Furnace Draft Pressure: Loss #1

☒ Modify Opening Area: Loss #1

Baseline	Modifications
Opening Area	Opening Area
4 ft <sup>2</sup>	2 ft <sup>2</sup>

Back

- Calculate heat losses from several heater components
- Explore the savings from reducing flue gas oxygen or temperature, preheating air or charge materials, controlling furnace pressure, closing openings, etc.



# Fans

### CALCULATE FLOW AND PRESSURES

[Return to Setup](#)

#### 2 INPUT PLANE DATA

1 2 3a 3b 4 5

#### INPUT PITOT TUBE DIFFERENTIAL PRESSURE READINGS

INSERTION POINTS	TRAVERSE HOLES									
	1	2	3	4	5	6	7	8	9	10
1	0.662	0.568	0.546	0.564	0.463	0.507	0.865	1.17	1.247	1.63
2	0.639	0.542	0.53	0.57	0.603	0.75	0.965	1.014	1.246	1.596
3	0.554	0.452	0.453	0.581	0.551	0.724	0.844	1.077	1.323	1.62

[Finish and Return to Plane Data](#)

### RESULTS

[Use Static Pressure](#) [Use Total Pressure](#)

#### ASSESSMENT DATA

Inlet Pressure	-17.5500 in H <sub>2</sub> O
Outlet Pressure	6.64900 in H <sub>2</sub> O
Flow Rate	379,792 ft <sup>3</sup> /min

#### FULL PLANAR RESULTS

Plane #	Gas Density lb/scf	Volume Flow ft <sup>3</sup> /min	Gas Velocity ft/min	Static Pressure in H <sub>2</sub> O	Velocity Pressure in H <sub>2</sub> O	Total P in
1	0.0209268	379,792	5,834.67	-17.5500	0.593081	-16
2	0.0220295	361,787	9,541.64	6.64329	1.66502	8.3
3a	0.0208934	191,147	5,873.12	-18.1000	0.00000	0.0
3b	0.0209602	188,649	5,796.35	-17.0000	0.00000	0.0
4	0.0209268	379,792	5,834.67	-17.5500	0.593081	-16
5	0.0135984	584,468	25,105.7	1.80000	7.13531	8.9

### Fan Example

Last modified: Aug 28, 2018

System Setup **Assessment** Diagram Report Sankey Calculators

Explore Opportunities [Modify All Conditions](#)

Novice View Expert View

Fluid Fan Motor

#### Field Data

BASELINE		REDUCE PRESSURE AND FLOW	
Operating Fraction	1	Operating Fraction	1
Cost	0.06 \$/kWh	Cost	0.06 \$/kWh
Inlet Pressure	-16.35 in H <sub>2</sub> O	Inlet Pressure	-19.15 in H <sub>2</sub> O
Outlet Pressure	1.1 in H <sub>2</sub> O	Outlet Pressure	1.29 in H <sub>2</sub> O
Flow Rate	129691 ft <sup>3</sup> /min	Flow Rate	86461 ft <sup>3</sup> /min
Power	450 kW	Specific Heat Ratio (γ)	1.4
Motor Power	460 kW	Compressibility Factor	0.988
Measured Voltage	460 V		
Specific Heat Ratio (γ)	1.4		
Compressibility Factor	0.988		

☐ Optimize Pump and Motor combination for a Fixed Specific Speed

Size Margin 0 %

Implementation Costs 5

#### RESULTS

Baseline		Reduce Pressure and Flow	
Percent Savings (%)			
21%			
Fan Energy Index	01	01	
Fan efficiency (%)	63.4	63	
Motor rated power (hp)	600	600	
Motor shaft power (hp)	577.9	454.7	
Fan shaft power (hp)	554.9	438.5	
Motor efficiency (%)	95.6	95.7	
Motor power factor (%)	85.7	83.8	
Motor current (amps)	659.4	530.7	
Motor power (kW)	450	354.4	
Annual Energy (MWh)	3,842	3,104	
Annual Energy Savings (MWh)	—	838	
Annual Cost	\$238,520	\$198,254	
Annual Savings	—	\$50,266	

[View Report](#)

- Compute motor full load amps, load current and power factor, pressure and flow from a traverse analysis, and fan and motor efficiency
- Explore the savings from changing fan and motor efficiency (which can be optimized automatically), flow and pressure, or even fluid characteristics

# Steam

**Steam Example**  
Last modified: Sep 22, 2020

System Setup **Assessment** Diagram

Explore Opportunities Modify All Conditions  
Novice View Expert View

**SELECT POTENTIAL ADJUSTMENT PROJECTS**  
Select potential adjustment projects to explore opportunities to increase efficiency and the effectiveness of your system.

[Add New Scenario](#)

Modification Name:

☐ Adjust General Operations

☐ Adjust Unit Costs

☐ Adjust Boiler Operations

☒ Adjust Condensate Handling

☒ Adjust High Pressure Condensate Recovery Rate

Baseline	Modifications
Condensate Recovery Rate 50%	Condensate Recovery Rate <input type="text" value="75"/> %

☒ Adjust Medium Pressure Condensate Recovery Rate

Baseline	Modifications
Condensate Recovery Rate 50%	Condensate Recovery Rate <input type="text" value="75"/> %

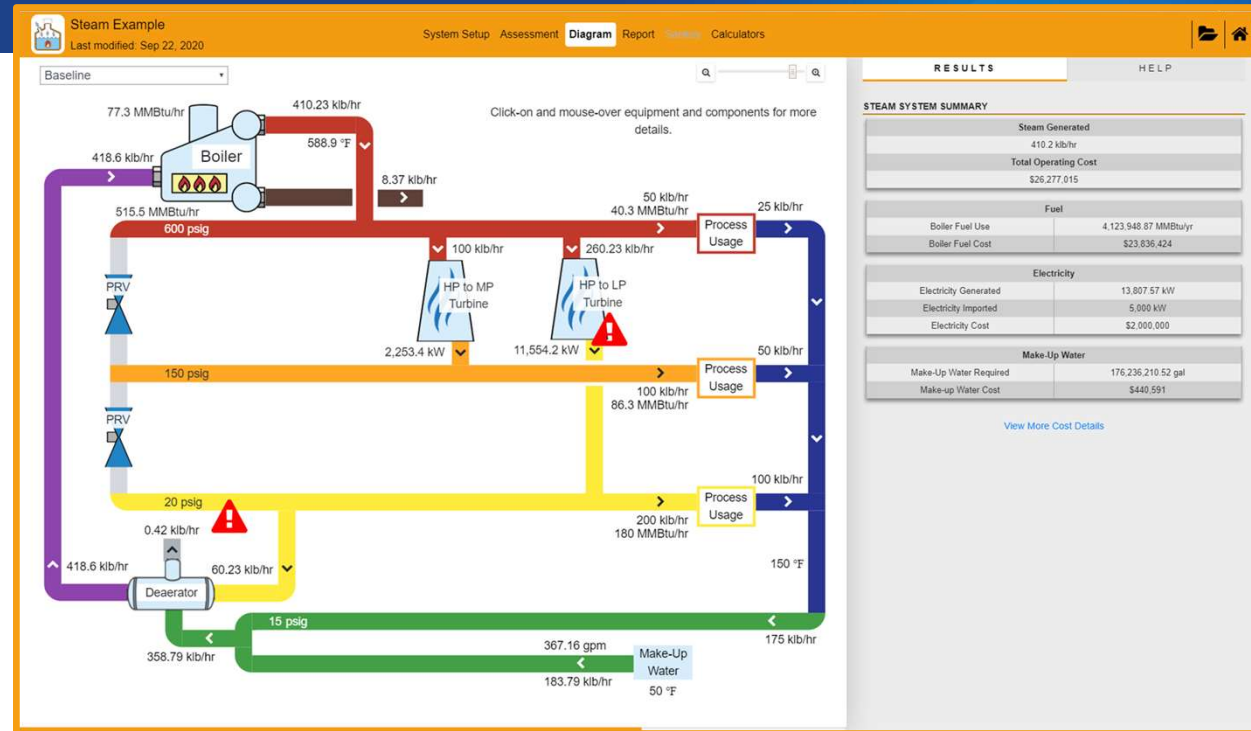
☒ Adjust Low Pressure Condensate Recovery Rate

Baseline	Modifications
Condensate Recovery Rate 50%	Condensate Recovery Rate <input type="text" value="75"/> %

☐ Flash Condensate to Medium Pressure

☐ Flash Condensate to Low Pressure

☐ Modify Condensate Return Temperature



- Determine steam flows, fuel use, electricity production throughout system
- Explore the savings from adding/removing turbines, adding flash tanks, increasing condensate recycle, etc.

# Treasure Hunt

**Treasure Hunt Example**  
Last modified: Sep 23, 2020

Facility Basics **Find Treasure** Treasure Chest Report

Find ways to save your hard earned treasure!  
Use one of the following calculators to determine savings opportunities within your manufacturing facility.  
Once an opportunity has been found, save the opportunity to your "Treasure Chest".  
Add more details to each opportunity by clicking the icon and filling out an opportunity sheet.  
Click the "Treasure Chest" tab to view a summary of your found treasures.

Filter Calculators by Utility Type: All

- Lighting Replacement**  
The calculator is designed to quantify the energy savings associated with lighting opportunities.
- Replace Existing Motor**  
This calculator calculates the energy savings, cost savings, and payback period for replacing an existing motor with a higher efficiency motor.
- Upgrade Motor Drive**  
The Motor Drive Calculator compares the annual energy cost of three motor drives: V-belt drive, Notched V-Belt drive, and Synchronous Belt Drive.
- Natural Gas Reduction**  
This calculator is used to quantify the energy savings associated with reducing natural gas usage.
- Electricity Reduction**  
This calculator is used to quantify the energy savings associated with reducing electricity usage.
- Compressed Air Reduction**  
This calculator is used to quantify the energy savings associated with reducing compressed air usage.
- Compressed Air Pressure Reduction**  
This calculator is used to quantify the energy savings associated with reducing compressed air system pressure.
- Water Reduction**  
This calculator is used to quantify the energy savings associated with reducing water usage and wastewater disposal.
- Steam Reduction**  
This calculator is used to quantify the energy savings associated with reducing steam use.
- Pipe Insulation**  
This calculator is used to quantify the energy savings associated with insulating hot pipes.
- Tank Insulation**  
This calculator is used to quantify the energy savings associated with insulating tanks.
- Compressed Air - Leak Survey**  
Used to quantify the energy savings associated with compressed air leaks.
- Custom Savings Opportunity**  
This calculator provides a space to add custom savings opportunities.

Energy Efficiency & Renewable Energy

**Treasure Hunt Example**  
Last Modified: 9/23/20, 12:12 PM

Utility Type: Calculator Type: Teams: Equipment: Print Export to CSV

**Executive Summary** Opportunity Summary Opportunity Payback Details Report Graphs Facility Info

**Cost Summary**

Utility	Cost Savings	Implementation Cost	Payback
Electricity	\$153,282	\$120,550	0.79
Natural Gas	\$43,901	\$10,200	0.23
Water	\$6,628	\$2,300	0.35
Mixed	\$100	\$100	0.92
<b>Total</b>	<b>\$203,811</b>	<b>\$133,150</b>	<b>0.65</b>

**Savings From Baseline vs Modification Costs**

Utility	Savings From Baseline	Modification Costs
Electricity	\$153,282	\$120,550
Natural Gas	\$43,901	\$10,200
Water	\$6,628	\$2,300

**Detailed Summary**

Utility	Current Use
Electricity	kWh 32,000,000
Natural Gas	MMBtu 125,000
Water	kgal 40,000,000
Mixed	
<b>Total</b>	

**Team Summary**

**Payback Length Summary**

Payback Length	Number of Opportunities	Total Savings
Less than 1 year	12	\$159,912
1 to 2 years	1	\$505
2 to 3 years	1	\$6,962
More than 3 years	2	\$6,436
<b>Total</b>	<b>16</b>	<b>\$203,811</b>

**Total Savings by Payback Length**

Payback Length	Total Savings
Less than 1 Year	\$159,912
1 to 2 Years	\$505
2 to 3 Years	\$6,962
More than 3 Years	\$6,436

**Payback Length Distribution**

Payback Length	Number of Opportunities
Less than 1 Year	12
1 to 2 Years	1
2 to 3 Years	1
More than 3 Years	2

- Find low/no cost energy savings opportunities in motor systems, process heating, compressed air, lighting, etc.

# Calculators

- 50+ Stand alone Calculators
  - Motors
  - Pumps
  - Fans
  - Process Heating
  - Steam
  - Compressed Air
  - Lighting
  - General
- Most have graphical results

## Motors Calculators



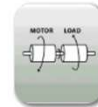
### NEMA Energy Efficiency

Shows the predicted efficiency of an induction motor, based on size, rotating speed and efficiency class



### Motor Performance

Plots current, efficiency, power factor vs motor shaft load for a given motor description



### Percent Load Estimation

Calculate percent load via slip method or field measurements



### Motor Drive

Compares the annual energy cost of different motor drives



### Replace vs Rewind

Compares the cost and energy of rewinding a failed motor versus replacing it with a new energy-efficient model

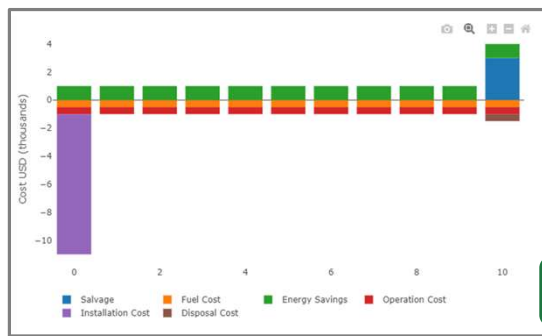
## Process Cooling Calculators



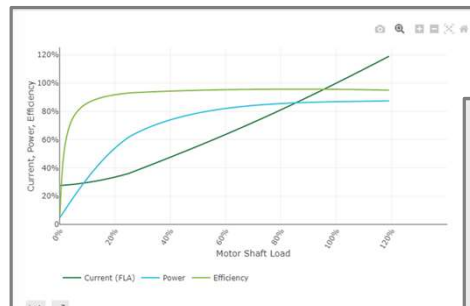
### Cooling Tower Makeup Water

Calculator for analyzing cooling tower water consumption.

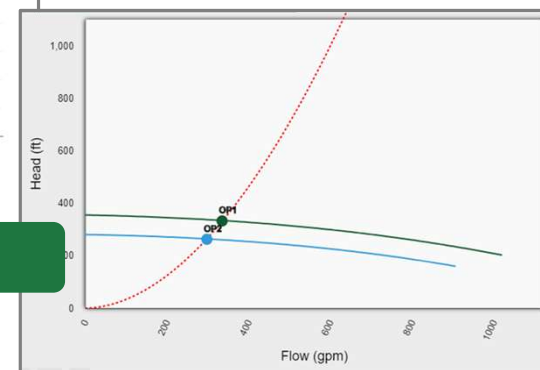
# Example Calculators



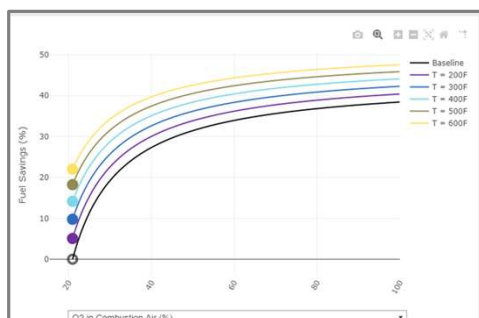
Cash Flow Diagram



Motor Performance

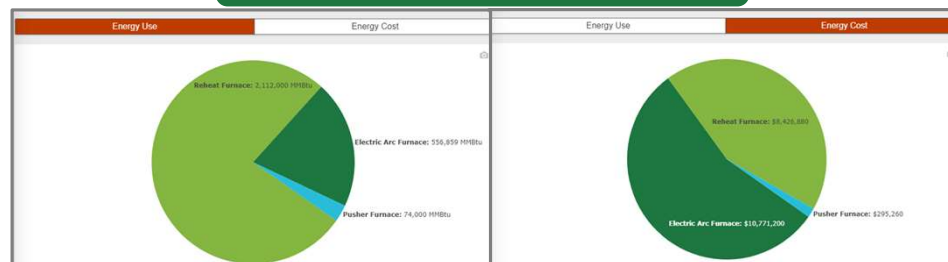


Pump Curve



O<sub>2</sub> Enrichment

Pre-assessment



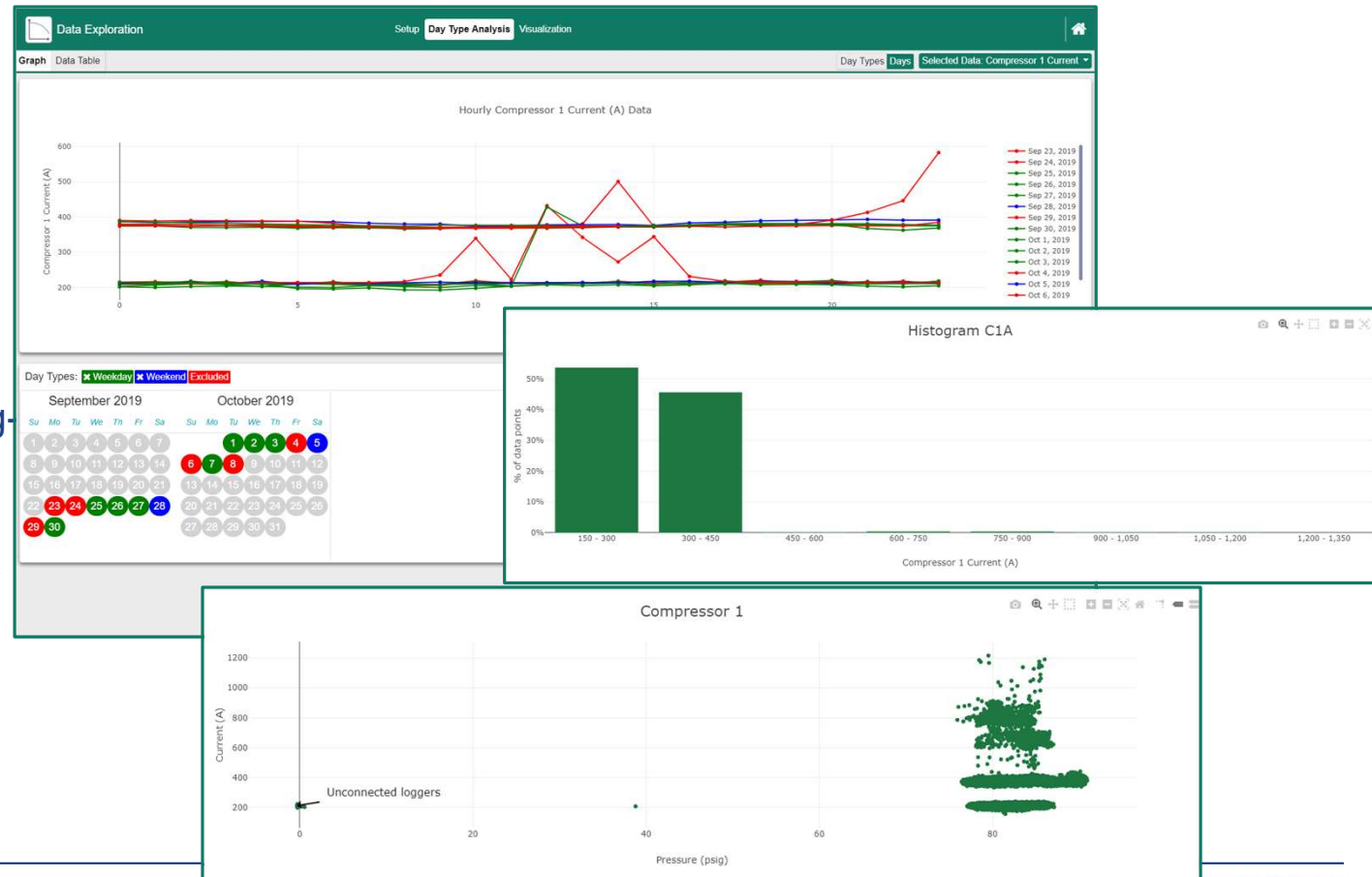
# Data Explorer

## ■ Two Key Functions

### ■ Day Type Analysis

- Used for finding hourly averages for similar load profiles
- For Compressed Air Assessment and other long-term analyses
- Based on LogTool

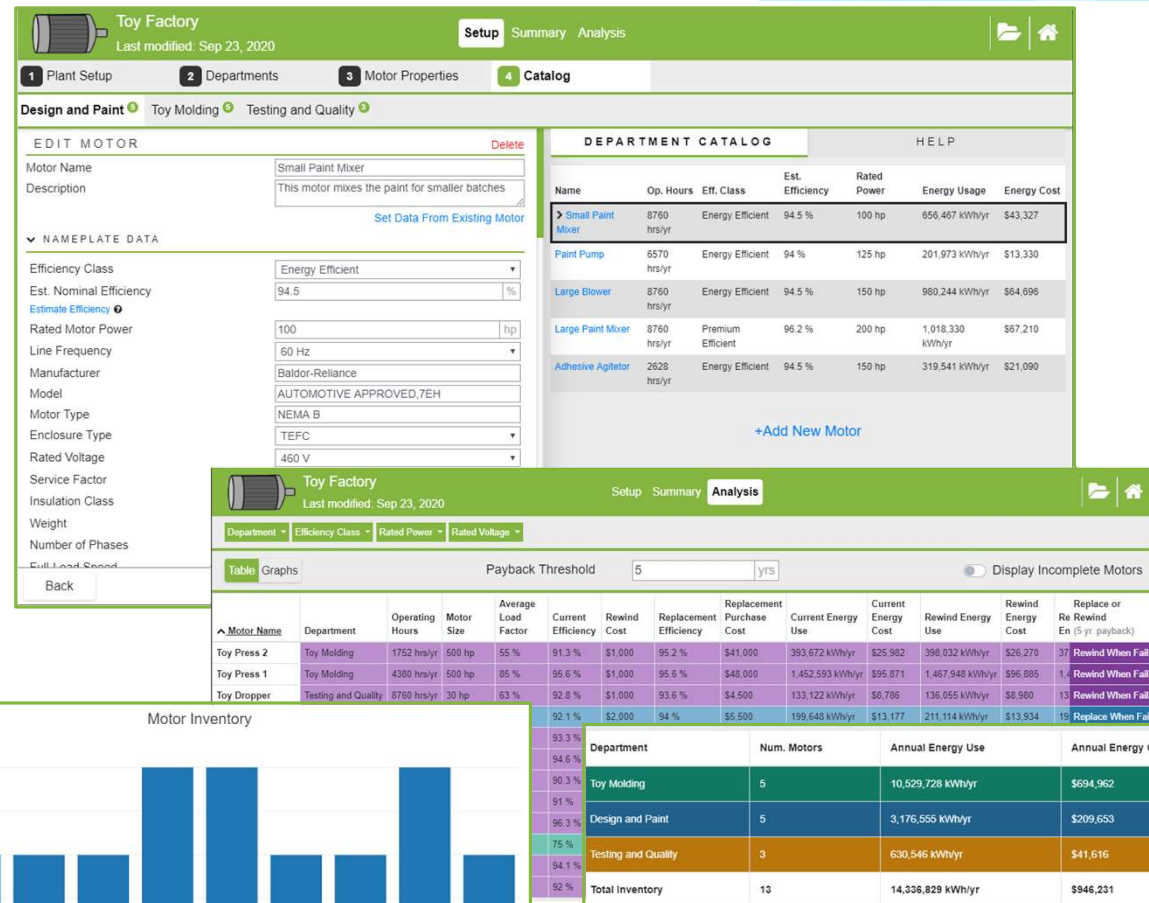
- Data Visualization – easy graphing capabilities to explore large datasets





# Equipment Inventories

- Modeled after MotorMaster
- Record key information about equipment in one place
  - Motors – Beta
  - Pumps, fans, compressors, maintenance - Planning
- Sort & filter, summary graphs, inventory printouts
- Batch analysis for simple calculators



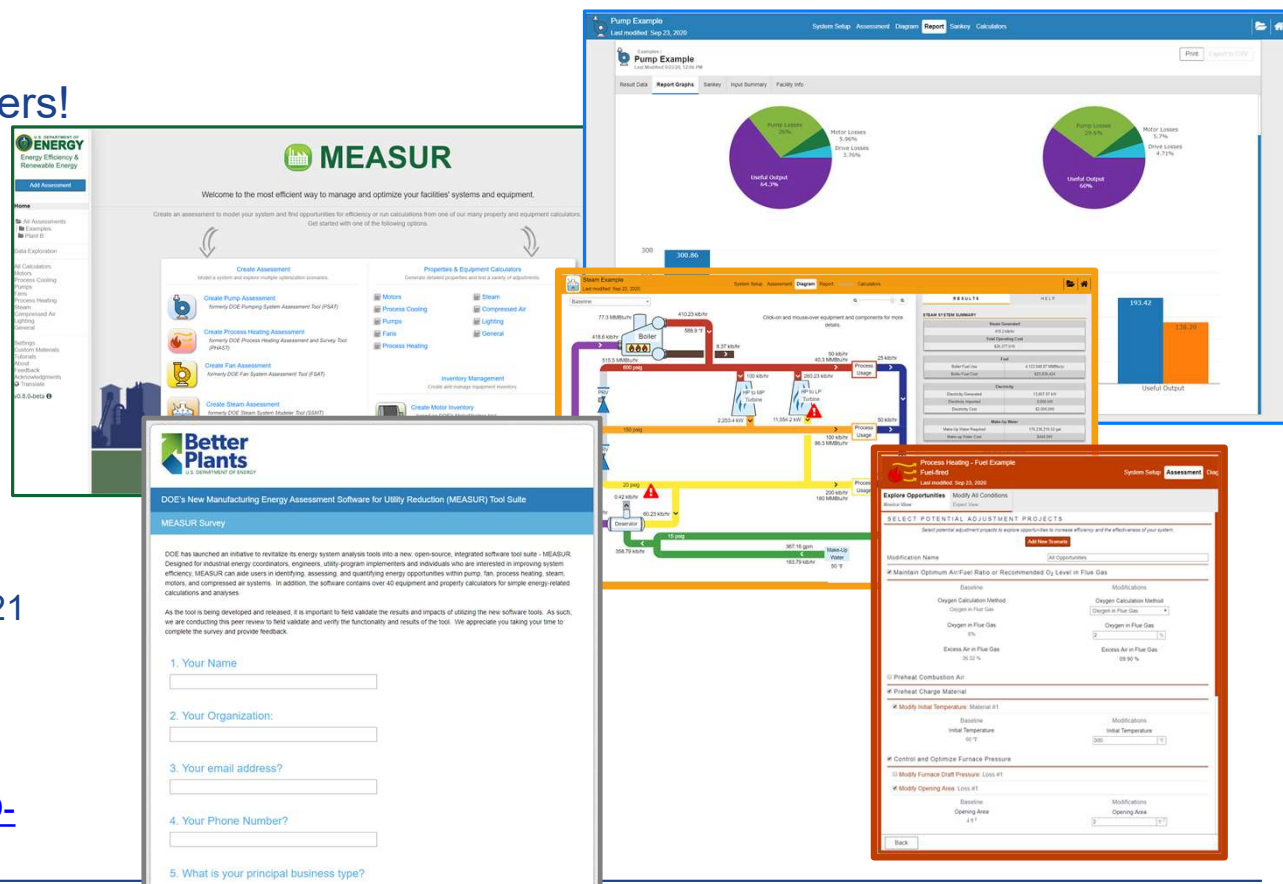
# Coming Soon

- Compressed Air Assessment
  - Modeled after AirMaster+ with LogTool
  - Conduct Compressed Air Energy Assessment
  - Quantify Energy Savings Opportunities
- More Equipment Databases
  - Modeled after MotorMaster+ Database
  - Keep inventory of equipment (pumps, fans, compressors, etc.) connected to assessments



# Results and Accomplishments

- **Community Engagement:**  
Key Point – want to engage end users!
- **Tool Development Schedule**
  - **Systems completed:**
    - Process Heat (PHAST)
    - Pumps (PSAT)
    - Fans (FSAT)
    - Steam (SSMT/SSAT)
    - Treasure Hunt
    - Motor Inventory
  - **Under Development:**
    - Compressed Air (AirMaster+) – 2021
    - Inventory – 2021
- [www.energy.gov/eere/amo/measur](http://www.energy.gov/eere/amo/measur)
- Ongoing Feedback link - <https://www.surveymonkey.com/r/DOE-AMO-TOOLS>



# Transition (beyond DOE)

What will this effort help enable going forward?

- **Open-Source** Library Suite - <https://github.com/ORNL-AMO>
  - Greater transparency
  - Future-proofing
  - New algorithms can be added to characterize other plant processes and equipment
  - Equipment providers can develop equipment specific databases that interface with the tool
- Library can be used to **effectively test** real-world equipment performance versus theoretic capabilities
- **Leverage sensors** for real-time data collection, monitoring and optimization
  - Leverage the Internet of Things devices coming online within manufacturing
- Enable **real-time system analysis and optimization**
  - Possibilities for exploring machine learning algorithms for system optimization

# Acknowledgements

## Subject Matter Experts

- Don Casada, Diagnostic Solutions, LLC
  - Developed the previous versions of PSAT and FSAT; contributed the PSAT algorithms for this version.
- Arvind Thekdi, E3M, Inc.
  - Developed the previous versions of PHAST and contributed algorithms to this version of PHAST
- Vern Martin, Mats Falk, Donovan Martin, FLOWCARE Engineering Inc.
  - Contributed algorithms for the new version of FSAT
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  - Contributed algorithms for the new version of FSAT
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  - Developed previous versions of DOE steam tools and continued to contribute to MEASUR by providing feedback.
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  - Reviewed and provided feedback for the Steam module.
- Walt Brockway
  - Reviewed and provided feedback for the Treasure Hunt module

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---

# Q & A

Submit Questions  
[www.slido.com](https://www.slido.com) event code #DOE



# Better Plants Online Learning Series

## ENERGY TREASURE HUNTS WITH EPA

Thr, Aug 20, 2020 | 1:00 - 2:00 PM ET

## PUMPS AND FANS

Thr, Aug 27, 2020 | 1:00 - 2:30 PM ET

## PROCESS HEATING & WASTE HEAT REDUCTION

Thr, Sep 3, 2020 | 1:00 - 2:30 PM ET

## FIELD VALIDATION

Thr, Sep 10, 2020 | 1:00 - 2:00 PM ET

## ENERGY MANAGEMENT DURING A PANDEMIC

Thr, Sep 17, 2020 | 1:00 - 2:00 PM ET

## MEASUR TOOL SUITE

Thr, Sep 24, 2020 | 1:00 - 2:00 PM ET

## PROCESS COOLING

Thr, Oct 1, 2020 | 1:00 - 2:00 PM ET

**REGISTER TODAY** >



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# Additional Questions?

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